P-2.5 Explain the factors that influence the dynamics of falling objects and projectiles.

Revised Taxonomy Level   2.7 B   Explain conceptual knowledge
Key concepts
Projectile motion

In physical science
❖ Students were introduced to the idea that all objects accelerate as they fall at the same rate, $9.8 m/sec^2$
❖ Students understand that the acceleration of gravity is a result of the gravitational force exerted by the earth.
❖ Students analyze the motion of a falling object during consecutive seconds of freefall in terms of
  ➢ Initial velocity
  ➢ Final velocity
  ➢ Average velocity
  ➢ Distance the object falls

As Physics for the Technology classes and traditional college prep classes will have different curricula based on the choices that are made for standards six through ten, the scope of the core curriculum should vary as well. The emphasis of topics within the core standards will depend on subsequent topics to be addressed.

It is essential for all physics students to
❖ Understand that objects projected upward experience the same gravitational force, and therefore the same acceleration as objects in free fall.
❖ Analyze the motion of an object projected directly upward
  ➢ Students should be given the initial velocity of the object
  ➢ Students should analyze consecutive seconds of motion for the complete trip (up and down) in terms of
    ♦ Initial velocity
    ♦ Final velocity
    ♦ Average velocity
    ♦ Distance traveled
❖ Analyze independently the vertical and the horizontal motion of a projectile which is projected upward at a 45° angle with the ground (ignoring air resistance)
  ➢ Horizontal Motion
    ♦ The object has an initial velocity in the horizontal direction
    ♦ The object has a constant velocity (1st Law) equal to the initial velocity
    ♦ The motion can be described as
       horizontal velocity = horizontal displacement/ time
  ➢ Vertical Motion
    ♦ The vertical motion is the same as an object which is projected straight upward
    ♦ Going up

- The object has an initial vertical velocity
- The object is slowing down due to the acceleration of gravity
- The final velocity of the object is zero (going up)
- $-9.8 \text{m/s}^2 = (0 \text{m/s} - \text{vertical } v_i) / t$

◆ Going down
- The object has an initial velocity of zero
- The object is speeding up due to the acceleration of gravity
- The object has a final velocity right before it hits the ground (which has same value as the initial velocity the object had when it began going up)
- $9.8 \text{m/s}^2 = (\text{vertical } V_f - 0 \text{m/s}) / t$

◆ The time going up equals the time going down.
➢ The time for the horizontal trip is equal to the total time for the vertical trip.

❖ Understand that the implication of this analysis is that projectiles hit the ground at the same time as objects that have not vertical motion.
❖ Use this knowledge to determine how changing each variable will effect the other variables for example, how does the initial vertical velocity effect the horizontal distance that a projectile travels.

College prep differentiation
❖ Understand that the initial velocity of a projectile (directed at the actual angle that the projectile is traveling) has a vertical and a horizontal component
➢ Understand that the vertical component of the velocity is the initial velocity as it goes up
➢ Understand that the horizontal component of the velocity is the object's the constant vertical velocity

Assessment

As the verb for this indicator is <u>explain</u> the major focus of assessment will be for students to "construct a cause and effect model". In this case, assessments will ensure that students can model how the velocity and the displacement of an object vary with time as an object is project upward, falls, or has trajectory motion.

Because the indicator is written as <u>conceptual knowledge,</u> assessments should require that students understand the "interrelationships among the basic elements within a larger structure that enable them to function together." In this case, assessments must show that students can construct a cause and effect statement relating how the velocity and the displacement of an object vary with time as the object rises or falls.